METHOD AND SYSTEM FOR REGISTERING FIDUCIALS EMPLOYING BACKLIGHTING TECHNIQUES

BACKGROUND OF THE INVENTION

[0001] The present invention relates to patterns employed to register objects. More particularly, the present invention is directed toward a workpiece that employs fiducial marks to align the workpiece with a tool.

[0002] During various manufacturing processes, it is desired to align a workpiece that is the subject of a manufacturing operation with a tool, i.e., an instrument that will operate on the workpiece during the manufacturing operation. To that end, the workpiece typically includes fiducial marks that are sensed by a detector to ensure proper alignment between the workpiece and the tool. Historically, the detector consisted of a human eye viewing a reticle having a fixed position with respect to the tool. Proper alignment between the workpiece and the tool would be achieved by changing the relative position of the reticle and the fiducial marks until a desired spatial proximity between the two were obtained.

[0003] The drive to increase productivity has resulted in an alignment process, as well as many other manufacturing processes, becoming automated. As a result, many current alignment processes employ machine vision devices, examples of which include optical detectors such as a charged-coupled-device or a charge-injection-device. The tool and the optical detector are typically fixed to a mount that is coupled to a stage. The workpiece is disposed on the stage and the alignment process is regulated by computer control. Operating under computer control, either the stage, detector, or both, may move until the detector senses that a fiducial is in predefined alignment with the optical detector. The predefined alignment corresponds to a desired spatial relationship between the workpiece and the tool.

[0004] Before obtaining the predefined alignment, however, the fiducial must be sensed by the detector. To that end, a top-down illumination source may be employed to facilitate sensing of the fiducial by the detector. **FIG. 1** shows a typical detection system that includes an optical detector **10** and a top-down illumination source **11**. Illumination source **11** directs light along a light path **11***a* to illuminate a region **12** of a workpiece **13**, where a fiducial **13***a* may be employed. Detector **10** has a field of view capable of sensing an area **14** of workpiece **13** that is smaller than region **12**. This arrangement is referred to as top-down-bright-field illumination, because light reflected from region **12**, and sensed by detector **10**, travels along the same light path **11***a* as light generated by illumination source, but in an opposite direction. In other words, detector **10** senses light that is specularly from region **12**.

[0005] Referring to **FIG. 2**, another example of top-down illumination is referred to as top-down-dark-field illumination. In this arrangement, illumination source **111** directs light along a path **111***a* to illuminate region **112** of workpiece **113**. Detector **110**, however does not sense specularly reflected light. Rather, detector **110** is orientated to sense light that reflects from region **112** and travels along a light path **111***b* that is not parallel to light path **111***a*. In this fashion, detector **110** senses light that is scattered from region **112**.

[0006] Referring to **FIG. 3**, yet another example of a detection system as described in U.S. Pat. No. 4,463,673 to Moore employs backlighting techniques. The detection system is employed in a registration apparatus **15** that includes a workpiece holder assembly **16**, a screen holder assembly **17**, and a registration plate **19**. Workpiece holder assembly **16** is provided with openings **16***a* for receiving lenses **20**. Each lens **20** covers a source of light (not shown) and is transparent to the light produced thereby. A screen **18** is attached to screen holder assembly **17**. Screen **18** is provided with a central region **18***a* having a pattern to be transferred to the workpiece (not shown), which may, for example, be a printed circuit board, integrated circuit, or the like. The region of screen **18** surrounding central region **18***a* is opaque to light and is provided with a pair of patterns **18***b* that have a cross-shaped configuration. The cross-shaped patterns are transparent to the light. Registration plate **19** is utilized to bring screen **18** into precise registry with the workpiece to be placed upon work holder assembly **16**. To that end, registration plate **19** is provided with a pair of registration patterns **19***a*, each being defined by quadrant shaped openings **19***b* that define a cross-shaped region. Quadrant shaped openings **19***b* are transparent to light, and the cross-shaped region is opaque to the light. The cross-shaped region has a profile that matches the profile of transparent cross-shaped registration patterns **18***b*. During registration, patterns **19***a* are positioned adjacent to one of lenses **20** and registration patterns **18***b* are positioned adjacent to one of patterns **19***a*. Thus, the condition of precise registration is determined by viewing the superimposed members **16** and **19** and observing light passed by members **16** and **19**. An absence of light indicates precise registration.

[0007] A drawback with the prior art detection systems is the inability to attenuate information associated with light reflected from anomalies proximate to the fiducials/registration patterns. As a result, the detection systems cannot determine proper alignment of the workpiece with respect to the tool.

[0008] What is needed, therefore, is a detection technique that overcomes the drawbacks associated with the prior art and enables proper alignment of the workpiece with respect to the tool.

SUMMARY OF THE INVENTION

[0009] An embodiment of the present invention provides advantages to satisfy the aforementioned need with a method for determining an alignment of a workpiece with respect to a tool by passing electromagnetic energy through a fiducial associated with the workpiece, with electromagnetic energy emerging from the fiducial defining an emergent flux; ascertaining a circumference of the emergent flux; and determining the alignment as a function of the circumference. Another embodiment of the present invention includes a system that functions in accordance with this method to provide advantages to satisfy the aforementioned need.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] **FIG. 1** is a perspective view of fiducial detection system that employs top-down-bright-field illumination in accordance with the prior art;

[0011] **FIG. 2** is a perspective view of fiducial detection system that employs top-down-dark-field illumination in accordance with the prior art;